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BY
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THE GASTROGRAPH:

A NEW MEANS OF DETERMINING THE MECHANICAL ACTION OF THE STOMACH.*

By MAX EINHORN, M. D.

UNDER mechanical action of the stomach one understands the changes which substances there undergo by the existing motions of this organ.

At the end of the last century, when physiology began to develop, several theories of the physiological function of the stomach took their origin. The oldest of these theories and the one which enjoyed most recognition was that of trituration, the food in the stomach being broken into small particles and changed into chyme. In the stomach of birds—where glass beads experimentally introduced were found, as you all know, broken into small fragments—one saw the proof for the correctness of the mechanical theory. Even then, however, before the chemical qualities of the gastric juice were known, two other theories had been constructed—the fermentative and the chemical. The advocates of the fermentative theory explained the digestive act as a kind of decomposition of the food by a putrid-like process. The chemists, however, looked for the active principle in the saliva and in the gastric juice.

Haller † believed that the food only became softened and diluted by the gastric juice, the process of maceration being aided and accelerated by the warmth, the putrefactive principle, and the slight but continuous motions to which the aliments are subjected.

Réaumur and Spallanzani ‡ endeavored to bring light upon this subject by way of ingenious experiments. They had animals swallow wooden capsules filled with food (meat), the capsules having several holes so as to admit the gastric juice into them. After a few hours the animals were killed, the stomach opened, and the capsules obtained; they were always found empty—*i. e.*, the meat had been digested. This experiment unmistakably showed the important part of the gastric juice for digestion. The other theories seemed thus to be overthrown, and the chemical alone to be the right one.

The mechanical action of the stomach from that time on until the end of the first quarter of this century was considered of hardly any value.

Thus Magendie # describes the act of gastric digestion in the following way:

"The aliment remains in the stomach generally about one hour before it undergoes any perceptible change, but what arises from its mixture with the fluids which are constantly poured into this organ. *During this time the stomach remains uniformly distended;* at last the pyloric portion contracts itself, through its whole extent, especially toward the point nearest to the cardiac portion, during which the aliments are forced back. From this time we find in the pyloric portion nothing but chyme mixed with a very small portion of aliment unchanged."

Johannes Müller * shares the same view, as can be seen from his following remarks:

"Only irritants applied directly to the stomach cause an immediate contraction. It is evident how mistaken those are who count much on the motions of the stomach for the dividing of the food into small particles. The peristaltic motions of the stomach I have never seen clearly. I therefore describe them after Magendie."

Richerand † emphasizes that the principal part of digestion is not performed in the stomach: "L'estomac a de tout temps été regardé comme le principal organe de la digestion; il n'y joue cependant qu'un rôle préparatoire et secondaire."

This author utilizes all the three theories in explaining the function of the stomach. He expresses himself as follows: ‡

"The soft and peristaltic action of the muscular fibers of the stomach exercises a slight pressure on the alimentary substances and triturates them finely. At the same time the gastric fluids soften and macerate the aliments before dissolving them. One might say that the process of gastric digestion is at the same time *chemical, mechanical, and vital.* In this way the authors of the different theories of the gastric mechanism have been wrong only inasmuch as they attributed this latter to *one* cause—namely, the warmth, the putrefaction, the trituration, the maceration, the gastric juices—instead of explaining it as an *act of all these causes united.*"

A new era in the physiology of gastric digestion begins with Beaumont.# His classical experiments on the Ca-

* Read before the Medical Society of the County of New York, May 28, 1894.

† Haller. *Elementa physiologiæ*, Bd. vi, Bernæ, 1764.

‡ Spallanzani. *Versuche über das Verdauungsgeschäft*, Abhandlung VI.

\# F. Magendie. *A Summary of Physiology*, Baltimore, 1824, p. 228.

* J. Müller. *Handbuch der Physiologie des Menschen*, 1837–1840, p. 483.

† Richerand. *Nouveaux élémens de physiologie*, Paris, 1825, t. i.

‡ Richerand. *Loc. cit.*, p. 234.

\# W. Beaumont. *Experimental Observations on the Gastric Juice.* Combe's Edition.

nadian St. Martin with the gastric fistula, executed during a period of several years, have greatly advanced all those important questions referring to the function of the stomach and remained undisputed to date. Beaumont knew the chemical properties of the gastric juice and gave a detailed description, from his own observations made on the Canadian, of the motions of the stomach and of the food. To illustrate Beaumont's views, we cite the following sentences* from his well-known book *Experimental Observations on the Gastric Juice:*

"That chymification is effected by the *solvent* action of the gastric juice, aided by the *motions* of the stomach, and the natural warmth of the system, not a doubt can remain in the mind of any person who has had an opportunity to observe its effects on alimentary substances.

" . . . These motions not only produce a constant disturbance, or churning of the contents of this organ, but they compel them at the same time to revolve around the interior from point to point, and from one extremity to the other. In addition to these motions there is a constant agitation of the stomach produced by the respiratory muscles." Page 102: "While these revolutions of the contents of the stomach are progressing, the trituration or agitation is also going on. There is a perfect admixture of the whole ingesta."

The movements of the food, according to Beaumont, take place in the following way:

"The ordinary course and direction of the revolutions of the food are, first, after passing the œsophageal ring, from right to left, along the small arch, thence through the large curvature from left to right. The bolus as it enters the cardia turns to the left, passes the aperture, descends into the splenic extremity, and follows the great curvature toward the pyloric end. It then returns in the course of the smaller curvature, and makes its appearance again at the aperture in its descent into the great curvature to perform similar revolutions. These revolutions are completed in from one to three minutes. . . . . The bulb of the thermometer, which has been frequently introduced during chymification, invariably indicates the same movement. They are slower at first than after chymification has considerably advanced."

W. Brinton † corroborated most of these facts by further experiments on animals and explained the admixture of the food in the stomach by the two existing different currents—one in the center, the other in the periphery of this organ.

Blondlot ‡ takes the same view as Richerand, laying, however, more stress on the mechanical action of the stomach, as may be seen from the following extracts:

"The stomach, as a whole, has to fulfill a triple rôle: Firstly (the most essential), to secrete the chymifying fluids; secondly, to serve as a receptacle for food during their chymification; thirdly, to act dynamically—namely, to mix the food and to expel it in the state of chyme. . . .

"Finally, the last quality attributed to the stomach is that of exercising a mechanical action on the aliments by means of the peristaltic movement with which it is provided."

M. Schiff,* on the contrary, attributes very little importance to the motions of the stomach. He says:

"Formerly much importance was attributed to the mechanical phenomena of the gastric digestion. By means of them one explained the maceration and even the dissolution of the aliments, and constructed strange hypotheses relating to the muscular force of the stomach. One even expressed in figures the supposed "enormous force" of the spiral fibers of this organ. Spallanzani and Réaumur, however, had already produced artificial digestions, and had proved by their experiments that the aliment need not be in immediate contact with the stomach wall in order to become liquefied and digested, . . . and we are entitled to say that, as a whole, in all mammals—including man—*it is the gastric juice alone which performs the gastric digestion.*"

The later physiologists have occupied themselves but very little with the subject in question. In this way one finds in most text-books either the description given by Beaumont or Schiff's opinion.

Whereas the experiments referring to the mechanical action of the stomach were left on the shelf, numerous investigations had been made in regard to the removal of the contents from the stomach into the intestines. This point

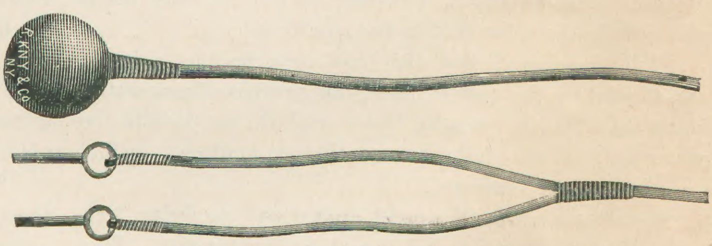

FIG. 1.—The ball apparatus of the gastrograph. (Natural size.)

alone during the last twenty years took the foremost interest, the more so since one had learned to utilize it in pathological conditions. According to Leube,† the stomach normally is empty seven hours after a substantial meal. Wherever this is not the case one speaks of a "faulty motion" of the stomach. One became accustomed to use the term "motility" for the transportation of food from the stomach into the intestines, leaving the mechanical action of the stomach without any consideration whatever. The transportation faculty of the stomach considerably gained in importance, since it has been proved, by experiments made on dogs by Mering,‡ Moritz,# and Hirsch, ‖ that the absorption of liquids through the stomach wall hardly amounts to anything.

Kussmaul, the founder of modern stomach pathology,

* Beaumont. *Loc. cit.*, p. 101.

† W. Brinton. Contributions to the Physiology of the Alimentary Canal. *The London Medical Gazette*, 1849, viii, p. 1025.

‡ Blondlot. *Traité analytique de la digestion*, Paris, 1843, pp. 187–189.

* M. Schiff. *Physiologie de la digestion*, 1867, t. i, p. 354.

† Leube. *Die Krankheiten des Magens und Darms.*

‡ Mering. *Münchener med. Wochenschrift*, Sept. 19, 1893, p. 721.

Moritz. *Ibid.*

‖ Hirsch. *Ctrlbl. für klin. Med.*, 1893, No. 18.

has written a very important paper touching our subject. His article on Peristaltic Restlessness of the Stomach forms a chapter of the pathology of the mechanical as well as of the transporting action of the stomach. We cite from Kussmaul * the following sentences:

"The peristaltic motions of the stomach in man, as a rule, remain concealed. Only under favorable conditions, if the abdominal walls are very thin and the stomach either situated very low or dilated, they become visible. But even then not always. On the other hand, in some persons we see the peristaltic motion in a picture, which I designate as 'peristaltic restlessness.' Here the peristaltic action is remarkably lively; the mountain waves which move over the stomach are large and powerful. Rest appears only when the stomach is empty from food and contains only air, or not even then."

In most of these patients there is a dilated stomach, with hypertrophied muscularis, in consequence of a stenosis either of the pylorus or of the duodenum. The peristaltic restlessness is, then, the result of a visible mechanical resistance; but it is also met with in cases without stenosis as the consequence of an increased irritability of the peristaltic nerve apparatus of the stomach. At another place in his article Kussmaul says: "The nervous peristaltic restlessness of the stomach is perhaps more frequent than it appears and not necessarily associated with dilatation. One merely can not perceive the motions of the stomach having its normal size and position. Even if the stomach is situated low, the motions can only be recognized in people with thin and relaxed abdominal walls."

Regarding the effect of the muscles of the stomach on the digestive process, Leube † expresses himself as follows:

"If one persuades himself of the effect which shaking produces in digestive fluids in test tubes, dissolving quickly substances contained therein, he will very easily conceive the importance of the gastric motions in this respect. By the contractions of the stomach wall the chyme apparently comes in contact with it at different places and becomes saturated with its juice. Likewise the contact of gastric contents with the stomach wall is fit to mechanically produce secretion anew."

C. A. Ewald ‡ very recently has made researches upon the motions of the chyme in the stomach, resembling those of Beaumont, on a patient with gastric fistula. We cite from Ewald the following: "I have gained the impression that the concussion of the stomach contents—which may be compared with the shaking of a sieve in the mill—serves as a very important factor in the mechanical admixture and the dissolution of the food stuffs."

In summing up the above-mentioned literature, it is evident that the stomach shows peristaltic motions and that they may be pathologically increased. There is, however, a discordance of opinion referring to the part which the mechanical action of the stomach plays in the churning of the food. This point has been least worked upon.

* A. Kussmaul. Volkmann's *Sammlung klinischer Vorträge*, No. 181, Jnni, 1880, p. 1637.

† Leube. *Die Krankheiten des Magens und Darms*, von Ziemssen, Bd. vii, p. 19.

‡ C. A. Ewald. *Zeitschrift f. klin. Medicin*, Bd. xx, p. 547.

It appeared to me of interest to make investigations on the subject in question. For several years I have been looking for some methods which would allow us to judge approximately of the mechanical action of the stomach. All usual methods of examining the motor faculty of the stomach can not be utilized for our object in view, for they all only consider the transportation of the contents, but not the motor work done by the stomach itself all the time. As the motions of the stomach necessarily cause a shaking of its contents, I tried to introduce into this organ separately two emulsifiable substances, and to withdraw them half an hour later by means of the tube; the idea was that the shaking would produce an emulsion. The tests, however, showed that generally there was no emulsion. At any rate, these experiments did not permit of any estimate of the mechanical action and were thus unfit for our purpose. Later on I tried to judge the contractions of the stomach by means of the stomach bucket; * the latter being within the stomach, one can observe how far, with what force, and at what intervals the thread on which the bucket hangs is pulled farther in. The thread alone affords too few supporting points to be moved by the contractions of the œsophagus. In this way every traction of the thread hints at a further locomotion of the bucket in the stomach. This method, however, is deficient for the reason that the motions of the bucket in the stomach will not be recognized as soon as a longer piece of thread has reached this organ.

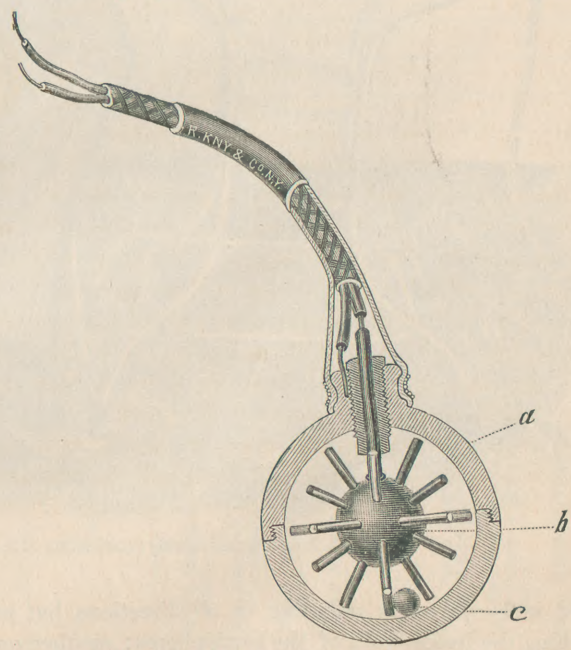

FIG. 2.—Cross section of the ball, showing its interior construction. (Enlarged three and a half times.) *a*, the two hemispheres; *b*, the spiked ball; *c*, the platinum ball.

Having the fact in view that, by the active (peristaltic) and passive (transmitted respiratory and pulsatory) motions of the stomach, there occurs a moving and at the same time shaking of the contents—which is the expression of the mechanical action—I have constructed an apparatus which indicates every motion to which it may be subjected

* Max Einhorn. *Medical Record*, July 19, 1890.

The whole apparatus comprises: 1. The ball (being the principal part). 2. A few electric cells. 3. The ticker.

The ball (Fig. 1) consists of two hollow metallic hemispheres (*a*), which are screwed together; within it is lodged and attached to the upper hemisphere, but perfectly insulated from the same at the attachment, another ball provided with spikes (*b*) radiating in all directions, but not touching the inside walls of the hemispheres; another very small platinum ball (*c*) lies within the large ball and can freely move in all directions, knocking at the spikes. (See Fig. 2.) Two insulated wires—one connected with the hollow ball, the other with the spiked ball—are incased in a very fine, thin rubber tube, forming the cable, and separate at the end into two branches, which must be attached to an electric battery. As soon as the platinum ball touches one of the spikes an electric circuit is made; as soon, however, as the platinum ball moves a little aside and does not touch the spike any more the current is broken. At each motion of the ball apparatus a rolling of the little platinum ball takes place and the electric current is either closed or broken. When the apparatus is at rest there is no change in the current. In connecting the "ticker" with the battery and the ball, each motion of the latter will be recorded on the paper in showing the "breaks" and "makes" of the current.

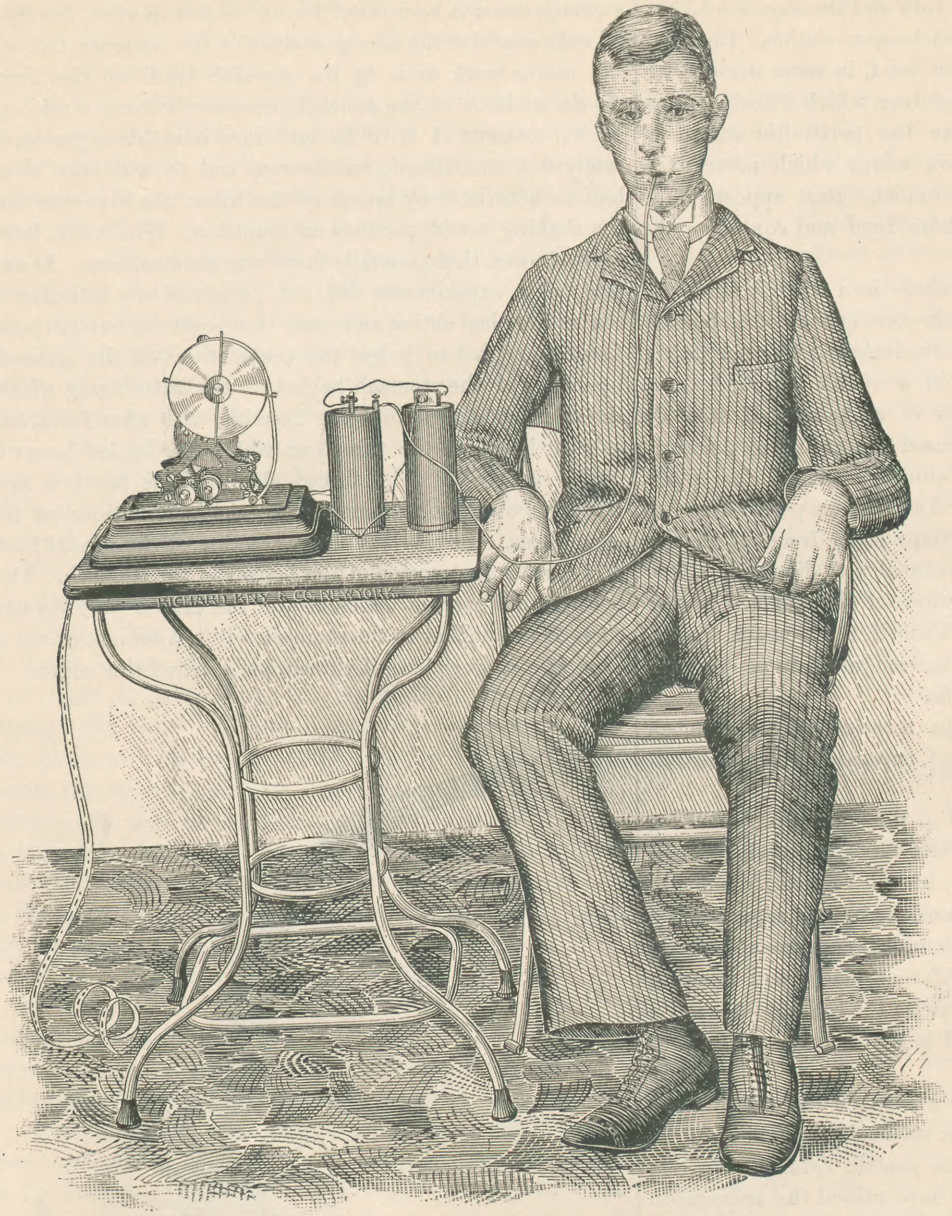

FIG. 3.—A patient undergoing examination with the gastrograph.

If the ball is swallowed and brought into the stomach, the motions of it—which are caused by the active and passive motions of the stomach—can be recorded in the same way as described.

This apparatus may therefore be designated as "Gastrokinesograph," or, shorter, "Gastrograph."*

From numerous tests which I have made, it appears with certainty that the gastrograph works in the desired manner—*i. e.*, it indicates the motions of the ball and can thus be utilized for the valuation of the motions of the stomach or the mechanical action of this organ.

Method.—The ball is dipped in lukewarm water, introduced into the pharynx of the patient, and the latter told to swallow. The patient may drink some water. After a short while (from a minute to a minute and a half) the ball reaches the stomach. It is advisable to let the ball slip far down into the stomach, so that the distance from the mouth to the ball (length of cable) is about fifty centimetres. The cable is then connected with the battery and the indicator and the latter set agoing for three minutes (Fig. 3). The patient during this procedure sits quietly on a comfortable chair. At the end of three minutes the indicator is checked, the cable disconnected from the battery, and the ball withdrawn from the stomach. When at the introitus œsophagi, it is necessary, here in the same way as when using the bucket † or the deglutable electrode, to have the patient swallow, and to

* The gastrograph may be obtained of Richard Kny & Co., 17 Park Place.

† Max Einhorn. *Medical Record*, July 19, 1890.

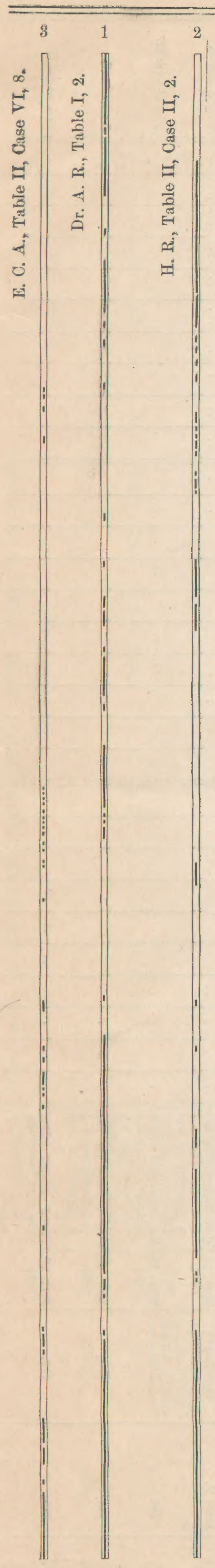

FIG. 4.

utilize the moment, when the larynx goes upward and forward, to withdraw the ball without using any force whatever.

The strip of paper which has rolled off from the reel is cut off and the marks are then perused. The black line shows when the current was closed, the empty places when there was no current. As an instance I give a few gastrograms (reduced ten times) (Fig. 4). For my experiments I have found it practical to enter the marks of the strips into a copy book. This was done in the following way: Each line was divided into three equal spaces—each space corresponding to one minute—each space (or minute) into ten divisions, and the "breaks" and "makes" of the current marked with dots at the corresponding place. In this way the number of current changes can very easily be looked over and comparisons made.

(A) *Physiological.* — I have made several tests with the gastrograph on healthy people and describe them in Table I.

These experiments show that the stomach is not so inactive mechanically as several authors believed, and that it churns the contents almost continuously with slight periodical interruptions.

The number of motions for three minutes averaged from four to forty-one.

When fasting, the mechanical action of the stomach seems to be much less than after meals. One hour after a light breakfast the gastrograph marked thirty-three in the case of Dr. A. R.

My experiments on healthy people are not numerous enough and will have to be largely supplemented.

(B) *Pathological.*—Most patients had been examined with the gastrograph either when fasting or from an hour to an hour and a half after the test breakfast, taking about half a glassful of water when swallowing the ball; many of the patients have been examined under both

TABLE I.—GASTROGRAMS OF HEALTHY INDIVIDUALS.

No.	Name.	Date.	Condition.	1.										2.										3 (minutes).										Number of dots.
				1.		3.		5.		7.		9.		11.		13.		15.		17.		19.		21.		23.		25.		27.		29.		
1.	Dr. A. R.	Jan. 10, 1894.	When fasting + one glassful of water.		...	....	.		..	.	.	.	.	.	.						.		.	.			.	..	.					14+4+5=23.
2.	Dr. A. R.	Mar. 28, 1894.	One hour after the test breakfast + ½ a glassful of water.		..	.	.	..	...	.			.	..	...	..	...		...			..	.		.			...	..					11+16+6=33.
3.	Carl G.	Feb. 23, 1894.	When fasting, without any water.								.										.							.	.					1+1+2=4.
4.	Carl G.	Feb. 23, 1894.	When fasting + ½ a glassful of water.			.									.								.									.	.	1+2+2=5.
5.	Carl G.	Jan. 28, 1894.	An hour and a quarter after a light breakfast, without any water.	.	.		.		.	..	...	..	.	...	..	..	...		..	..	.	.	.		.	..			.		...	...	..	12+17+12=41.
6.	Carl G.	Jan. 12, 1894.	Two hours after breakfast + 1 glassful of water.	.		..								.			.		..		.		.		.		..		.	..			.	3+6+7=16.
7.	Carl G.	Feb. 25, 1894.	An hour and three quarters after breakfast + ½ a glassful of water.	.									.								..				.	..		.		.	.	.		2+2+7=11.
8.	Carl G.	Feb. 25, 1894.	Do. (Further 3 minutes.)	.			..	.				.	.		.					.	.		.						.		.	.	.	6+4+4=14.

TABLE II.—GASTROGRAMS OF PATIENTS WITH STOMACH TROUBLES.

No.	Name.	Disease.	Date.	Condition.	Number of dots.
I, 1.	Dr. D.	Dilatatio ventriculi; hyperaciditas.	Jan. 13, 1894.	Two hours after dinner + ½ a glassful of water	15+11+10=36.
II, 2.	H. R.	Gastritis gland. chron.	May 12, 1894.	One hour after test breakfast + ½ a glassful of water.	16+8+7=31.
III, 3.	H. B.	Dilatatio ventriculi; hyperaciditas.	Jan. 8, 1894.	After washing of the stomach +1 glassful of water.	9+7+3=19.
4.	Do.	Do.	Feb. 25, 1894.	An hour and a half after a cup of coffee + ½ a glassful of water.	6+9+6=21.
5.	Do.	Do.	Mar. 25, 1894.	When fasting + ½ a glassful of water.	10+5+0=15.
IV, 6.	H. S.	Gastritis gland. chron.	Feb. 7, 1894.	When fasting + ½ a glassful of water.	9+6+5=20.
V, 7.	Augusta S.	Do.	May 7, 1894.	An hour after the test breakfast + ½ a glassful of water.	13+14+3=30.
VI, 8.	Edward C. A.	Dilatatio ventriculi; hyperaciditas.	Mar. 26, 1894.	An hour and a quarter after the test breakfast + ½ a glassful of water.	4+14+15=33.
VII, 9.	B. S.	Gastralgia.	Jan. 21, 1894.	Two and a half hours after the test breakfast + ½ a glassful of water.	5+5+4=14.
VIII, 10.	H. F.	Gastro-succorrhœa continua chron.	Jan. 15, 1894.	When fasting + ¾ of a glassful of water.	3+6+8=17.
X, 11.	Friedrich G. J.	Carcinoma pylori; "peristaltic restlessness of the stomach."	Feb. 2, 1894.	After washing of the stomach + ½ a glassful of water.	14+14+12=40.
12.	Do.	Do.	Mar. 23, 1894.	When fasting + ½ a glassful of water.	0+3+19=22.
X, 13.	N. C. S.	Ectasia ventriculi; stenosis pylori ex cicatrice; hyperaciditas.	Feb. 15, 1894.	After washing of the stomach + ½ a glassful of water.	0+12+0=12.
XI, 14.	Max B.	Excessive anorexia; neurotic trouble of the stomach.	Feb. 1, 1894.	Three hours after test breakfast + ½ a glassful of water.	13+14+12=39.
XII, 15.	William U.	Ectasia ventriculi; stenosis pylori ex cicatrice; hyperaciditas.	May 21, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.	33+28+22=83.
XIII, 16.	Rev. S.	Boulimia; hyperaciditas.	Mar. 14, 1894.	Two hours after the test breakfast + ½ a glassful of water.	9+3+28=40.
17.	Do.	Do.	Mar. 18, 1894.	An hour and three quarters after the test breakfast + ½ a glassful of water.	17+14+1=32.
18.	Do.	Do.	Mar. 20, 1894.	One hour after the test breakfast + ½ a glassful of water.	5+1+0=6.
19.	Do.	Do.	Mar. 20, 1894.	Three hours after the test breakfast + ½ a glassful of water.	11+0+0=11.

TABLE II (*Continued*).—GASTROGRAMS OF PATIENTS WITH STOMACH TROUBLES.

No.	Name.	Disease.	Date.	Condition.	1.										2.										3 (minutes).										Number of dots.
					1.		3.		5.		7.		9.		11.		13.		15.		17.		19.		21.		23.		25.		27.		29.		
XIV, 20.	Adolph S.	Gastro-succorrhœa continua chron.; hyperaciditas; hyperkinesis.	Mar. 8, 1894.	When fasting + ½ a glassful of water.		.									.						.					.		.	..			.		..	1+2+7=10.
21.	Do.	Do.	Mar. 8, 1894.	Twenty minutes after the test breakfast + ½ a glassful of water.																															0+0+0=0.
22.	Do.	Do.	Mar. 4, 1894.	Three quarters of an hour after the test breakfast + ½ a glassful of water.	.												..																		1+2+0=3.
23.	Do.	Do.	Mar. 11, 1894.	When fasting + ½ a glassful of water.	.					.	.	.										.				.	.			.				.	4+1+4=9.
24.	Do.	Do.	Mar. 11, 1894.	Twenty-five minutes after the test breakfast + ½ a glassful of water.	.	.						.			..		.	..		.			..		.						.	.			3+8+3=14.
25.	Do.	Do.	Mar. 15, 1894.	When fasting + ½ a glassful of water.	.	..				...	...	..											.			.	...								11+1+4=16.
26.	Do.	Do.	Mar. 8, 1894.	Two hours after the test breakfast + ½ a glassful of water.	.	....	...	..	....			.		.																					16+0+0=16.
27.	Do.	Do.	Mar. 18, 1894.	One hour after the test breakfast + ½ a glassful of water.											.						.														0+2+0=2.
28.	Do.	Do.	Apr. 8, 1894.	When fasting + ½ a glassful of water.			..	..	...	..			.		..	....	..	...																	10+11+0=21.
29.	Do.	Do.	Apr. 15, 1894.	When fasting + ½ a glassful of water.		.	.	.		.	.																								5+0+0=5.
30.	Do.	Do.	Apr. 29, 1894.	Half an hour after the test breakfast + ½ a glassful of water.																															0+0+0=0.
XV, 31.	Frank G.	Gastro-succorrhœa continua periodica (during the attack).	Feb. 22, 1894.	One hour after the test breakfast + ½ a glassful of water.		.			.	.				.	..																				4+2+0=6.
32.	Do.	Do.	Feb. 25, 1894.	When fasting + ½ a glassful of water.		.	.		.	.		.			.		.		.		.							.			.				5+4+2=11.
XVI, 33.	Edwin N. D.*	Atonia ventriculi; dilatatio.	Apr. 25, 1894.	When fasting + ½ a glassful of water.																															0+0+0=0.
34.	Do.	Do.	Apr. 28, 1894.	One hour after the test breakfast + ½ a glassful of water.		.											.	.												.					1+2+1=4.
35.	Do.†	Do.	May 5, 1894.	One hour after the test breakfast + ½ a glassful of water.	.	..		...		...	.		.		..	.	...		...																11+9+0=20.
XVII, 36.	Fredrick W.	Gastritis gland. chron.; dilatatio ventriculi.	Apr. 1, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.	.	.		.							.																				3+1+0=4.
37.	Do.	Do.	Apr. 1, 1894.	Do. (Further 3 minutes.)			.	.	.	..		.			.	.					.	.	.		.		.				.		.		6+5+4=15.
XVIII, 38.	Robert F.	Dilatatio ventriculi; hyperaciditas.	Mar. 22, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.								.																	.		.			.	1+0+3=4.
39.	Do.	Do.	Mar. 25, 1894.	An hour and three quarters after the test breakfast + ½ a glassful of water.				.		.			..				.	.	..	.	.	.													4+7+0=11.
40.	Do.	Do.	Apr. 15, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.																															0+0+0=0.

* In the beginning of treatment there was slight stagnation of food.

† Patient is much better, and there is no more stagnation of food.

TABLE II (*Continued*).—GASTROGRAMS OF PATIENTS WITH STOMACH TROUBLES.

No.	Name.	Disease.	Date.	Condition.	1.										2.										3 (minutes).										Number of dots.
					1.		3.		5.		7.		9.		11.		13.		15.		17.		19.		21.		23.		25.		27.		29.		
XIX, 41.	Richard L.	Gastritis gland. chron.	Mar. 28, 1894.	Two hours after the test breakfast + ½ a glassful of water.		..					.						.											.			...	...	...		3+1+10=14.
XX, 42.	Hermann K.	Dilatatio ventriculi; hyperaciditas.	Jan. 23, 1894.	Two hours after the test breakfast + a glassful of water.										..			.											.							2+1+1=4.
XXI, 43.	Solomon C.	Do.	Jan. 2, 1894.	One hour after the test breakfast + ½ a glassful of water.	.	.	.		.																				.						4+0+1=5.
XXII, 44.	Wilhelm M.	Anæmia; dilatatio ventriculi; hyperaciditas.	Feb. 1, 1894.	When fasting + a glassful of water.	.											.																			1+1+0=2.
45.	Do.	Do.	Feb. 11, 1894.	Half an hour after a glassful of water + ½ a glassful of water.															.																0+1+0=1.
46.	Do.	Do.	Feb. 25, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.																	..														0+2+0=2.
47.	Do.	Do.	Mar. 3, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.	..																														2+0+0=2.
48.	Do.	Do.	Mar. 18, 1894.	Three hours after the test breakfast + ½ a glassful of water.	..																													.	2+0+1=3.
49.	Do.	Do.	Mar. 19, 1894.	One hour after the test breakfast + ½ a glassful of water.	.	.	.	.	.	..			.																						8+0+0=8.
50.	Do.*	Do.	Mar. 22, 1894.	When fasting + ½ a glassful of water.		..	...				..								..		.		..		.	..	...	..							7+5+8=20.
51.	Do.	Do.	Mar. 26, 1894.	When fasting + ½ a glassful of water.																														..	0+0+2=2.
52.	Do.	Do.	Apr. 12, 1894.	An hour and a half after the test breakfast + ½ a glassful of water.																								.							0+0+1=1.
53.	Do.	Do.	Apr. 12, 1894.	Do. (Further 3 minutes.)								.																							1+0+0=1.
XXIII, 54.	William C.	Gastritis gland. chron.; dilatatio ventriculi.	Feb. 27, 1894.	When fasting + a glassful of water.																															0+0+0=0.
55.	Do.	Do.	Feb. 27, 1894.	Do. (Further 3 minutes.)					.										.				.												1+2+0=3.
56.	Do.	Do.	Mar. 6, 1894.	One hour after the test breakfast + ½ a glassful of water.																															0+0+0=0.
XXIV, 57.	Sam. H.	Anorexia; neurotic affection of the stomach.	Mar. 10, 1894.	Two hours after the test breakfast + ½ a glassful of water.	.																													.	1+0+1=2.
XXV, 58.	Arthur B.	Ulcus ventriculi.	Mar. 3, 1894.	Two hours after the test breakfast + ½ a glassful of water.																															0+0+0=0.
XXVI, 59.	William W.	Ulcus ventriculi (?); hyperaciditas.	Mar. 19, 1894.	Two hours after the test breakfast + ½ a glassful of water.	.																														1+0+0=1.
XXVII, 60.	Jacob F.	Dilatatio ventriculi; hyperaciditas.	Mar. 24, 1894.	One hour after the test breakfast + ½ a glassful of water.																															0+0+0=0.
61.	Do.	Do.	Mar. 28, 1894.	One hour after the test breakfast + ½ a glassful of water.		..	.	..							.							.													5+2+0=7
62.	Do.	Do.	Mar. 31, 1894.	Two hours after a light breakfast + ½ a glassful of water.							.			.	.	.		..		.		.													2+6+0=8.
63.	Do.	Do.	Apr. 7, 1894.	When fasting + ½ a glassful of water.																															0+0+0=0.

* Patient felt better.

conditions on different days. Some of them have been subjected to a very great number of tests, in order to ascertain whether there is a certain constancy in the results. The whole number of patients examined was twenty-seven, the number of tests sixty-four.

Table II shows the tracings we obtained in our patients with the gastrograph.

In perusing the gastrograms obtained from my patients and comparing them with those obtained from healthy people, one sees that there are three different classes among them. One corresponds to the normal; the second class is marked with too much mechanical action, the number of dots being greatly increased; the third class shows a remarkable slowness and laziness of the mechanical function, the number of dots being reduced to 4, 3, or 0.

I might briefly state that in patient U. (xii, 15) with dilatation of the stomach and stenosis of the pylorus the number of dots was the largest.

Although these investigations are as yet not finished, they show, however, that the gastrograph will enable us to widen our knowledge of the mechanical function of the stomach. Moreover, it will probably prove of value as a new diagnostic means in some pathological conditions of this organ.

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